An electronic device for enteric methane emissions monitoring

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It is widely accepted that accumulation of greenhouse gases in the atmosphere, including methane (CH_4), is promoting climate change. Cattle contribute significantly to CH_4 emissions, mainly generated during ruminal fermentation. Measuring CH_4 emissions is expensive and time-consuming, hampering individual, constant, and scalable monitoring at the farm level. Thus, developing innovative methodologies to measure CH_4 emissions from cattle is crucial. These methodologies should enable the identification of lower-emitting animals and to assess the effectiveness of various mitigation strategies. This study aimed to develop a low-cost microcontroller-based device to record variations in CH_4 concentrations in the air exhaled by animals during indoor intake periods.The device was assembled into a plastic box with an internal compartment for an MQ-4 sensor that measures CH_4 concentration (ppm). The device is equipped with an air pump and a plastic tubing with a 4 mm diameter for air flow generation (2 L/min) from the feeder area to the sensor, ensuring individualized measurements. An ESP8266 module collects the sensor signal and sends it to a laptop through a Wi-Fi network. To test the device, emissions from 16 dairy cows were monitored at milking (5:00 and 16:00h) during three consecutive days. Variations in CH_4 concentration were recorded three times per second in a text file for each animal at milking times. The mean CH_4 concentration among the cows was 666 ppm (20.4% CV). Figure 1 compares emissions between two animals: a low-emitter (458 ppm, 4.1% CV) and high-emitter cow (853 ppm, 9.2% CV). The findings reveal the device's capability for monitoring CH_4 emissions on an individual basis, underscoring its value in promoting sustainability at the farm level. Future iterations could benefit from integrating sensors for temperature, humidity, and atmospheric pressure to refine CH_4 measurements. Additionally, distance measurement technologies could standardize the proximity of the air sampler to the animals, thereby enhancing the accuracy of the emissions captured. Implementing a CH_4 background reader could allow for continuous monitoring of ambient conditions, adjusting the CH_4 readings to account for fluctuations that might affect concentration levels. Finally, incorporating animal identification tools, such as RFID tags or computer vision identification systems, could automate the process of associating CH_4 emission data with specific animals, ensuring consistent data collection. These advancements would not only improve the precision of the device but also offer a more comprehensive understanding of individual enteric CH_4 emissions.

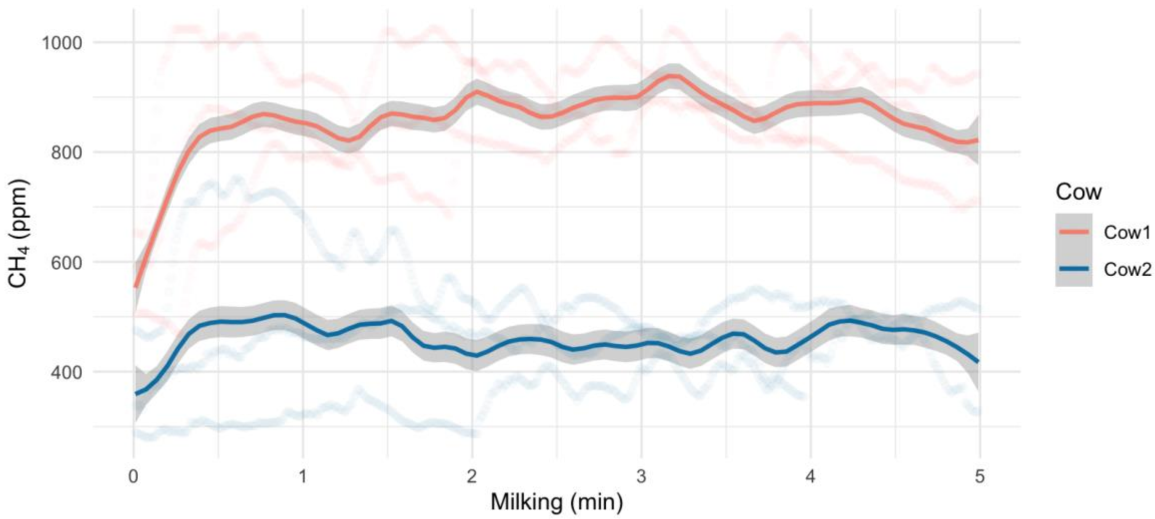

Figure 1: Comparison of CH_4 emissions (ppm) readings for low- and high-emitter cows, smoothed using LOESS with a 0.1 interval.